

Macroinvertebrate Assemblages in Mountain Streams in
Burned (Wildland and Prescription) and Unburned
Watersheds on the Payette National Forest, Idaho

Project Title: Macroinvertebrate Assemblages in Mountain Streams in Burned
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Annual Progress Report; Results from 2004

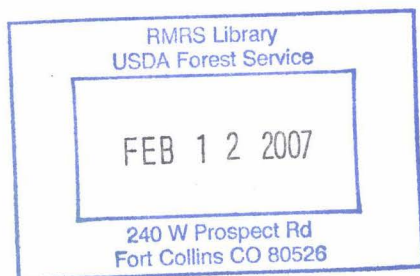
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Introduction

Despite growing awareness of the importance of fire in maintaining healthy forests, there remains a lack of information about the effects of fire on aquatic systems. Moreover, most existing research in western watersheds has examined only the effects of high-intensity, stand-replacement fires on stream biota. The response of lotic systems to low-intensity prescribed fires, which are in increasing use as a forest management tool, is largely unknown. To address this need, a team of scientists (Pilliod et al. 2001) has initiated a three-year investigation into the response of aquatic biota and habitat to fires of varying intensity. The research described in this annual report is a component of that investigation, and took place in two of the four study areas of the overall fire effects study: the Big Creek watershed in the Middle Fork of the Salmon River subbasin, and the South Fork of the Salmon River subbasin, both in central Idaho.

Watersheds in the Big Creek subbasin experienced wildfires of varying severity in 2000. As part of an ongoing stream study, we collected benthic macroinvertebrate samples in six Big Creek watersheds in 1998 and 1999 (Table 1). Samples from 1998 and 1999 will be used to compare pre- and post-burn macroinvertebrate communities in the Big Creek watershed.

Three watersheds in the South Fork of the Salmon subbasin have been selected for prescribed burns, and three adjacent watersheds will remain unburned as reference watersheds. We conducted pre-treatment benthic invertebrate sampling in seven streams either in 1999 or in 1999 and 2000 (Table 1). Macroinvertebrate samples from 1999, 2000 and 2002-2004 will be compared with samples collected in 2003-2004 to evaluate the effects of prescribed burning on macroinvertebrate communities.

This report describes progress and preliminary results of the first year of a three-year study. Macroinvertebrate sampling under this study began in 2002 and was completed in 2004.

Objectives

The overall goal of this study is to characterize the effects of prescribed and wildland fire on aquatic invertebrate communities. Specific objectives include:

1. To compare benthic invertebrate density, diversity, and community composition in watersheds treated with prescribed fire and reference watersheds in the South Fork of the Salmon River subbasin;
2. To compare benthic invertebrate density, diversity, and community composition in samples collected before and after wildland fire in streams

in the Big Creek watershed, Middle Fork of the Salmon River subbasin; and

3. To relate variation in benthic invertebrate metrics among different watersheds or years to stream habitat variables.

Study Areas

The South Fork of the Salmon subbasin is characterized by rugged topography, with elevations within the study area ranging from about 1120 m to 2800 m. Most soils in the subbasin are derived from Idaho Batholith granite. Upland vegetation is dominated by open ponderosa pine (*Pinus ponderosa*) forests at lower elevations, changing to mixed fir (*Abies* sp.) and Engelmann spruce (*Picea engelmannii*) forests at higher elevations. Fire history in the subbasin is varied, but no large stand-replacing fires have occurred within the study area in recent years.

Slopes in the Big Creek watershed are steep with pronounced topographic relief. Elevations within the study area range from about 1120 m to 2600 m.

Watersheds on the south side of Big Creek tend to be underlain by Challis Volcanics while watersheds to the north tend to be dominated by the Idaho Batholith; however, the geology of the area is complex, and most watersheds are underlain by several parent materials. Many of the watersheds within the Big Creek subbasin were extensively burned in August, 2000. Prior to the 2000 wildfires, vegetation ranged from open ponderosa pine and sagebrush (*Artemisia* sp.) at lower elevations to Douglas fir (*Pseudotsuga menziesii*) at mid-elevations and subalpine fir (*Abies lasiocarpa*) at higher sites.

Methods

We conducted macroinvertebrate sampling in seven Big Creek tributaries and seven South Fork of the Salmon River tributaries in August and September, 2004. We established five transects at 50-m intervals within a 200-m reach of each stream. The stream reach was selected to correspond with randomly selected, 200-m reaches used for amphibian, periphyton, and aquatic habitat sampling (Pilliod et al. 2001). We collected benthic invertebrate samples from one location along each transect ($n = 5$ samples per reach) using a standard Surber sampler (0.10 m², 500µm mesh) during summer base flow conditions. Each sample was preserved in 75-100% ethanol for later identification and enumeration in the laboratory. Aquatic insects were keyed to genus (Ephemeroptera, Odonata, Plecoptera, and Trichoptera) or family (Coleoptera, Diptera, and Lepidoptera). We calculated density, taxa richness, and Shannon diversity for each sample.

Additionally, we measured a number of stream attributes within each transect (Table 2). Stream characteristics and measurement methods were selected based

on their consistency with Forest Service and state aquatic habitat inventory procedures (Overton et al. 1997, DEQ 1997).

Results and Discussion

The macroinvertebrate communities in most streams were dominated by mayflies (Ephemeroptera; *Epeorus* and *Baetis*), particularly in South Fork Salmon streams (Table 3). Caddisflies (Trichoptera; *Arctopsyche*), midges (Chironomidae), and water beetles (*Heterlimnius*) were common in three Big Creek streams.

Macroinvertebrate densities and taxa richness were higher in the Big Creek study area than in South Fork Salmon streams (Table 3). Taxa diversity and evenness were also higher in Big Creek streams than in the South Fork Salmon study area (Table 3), but the differences were not great. South Salmon streams hosted a number of diverse taxa not found in Big Creek, while taxa that were unique to Big Creek streams were predominately stoneflies (Plecoptera) and beetles (Coleoptera). Mean macroinvertebrate densities in both watersheds were higher in 2004 than in 2002 or 2003.

Mayflies were the dominant order in most streams in the South Fork Salmon study area, with the exception of Deadman Creek (Figure 1). Caddisflies were the most abundant insects in Cabin Creek in the Big Creek subbasin, while true flies (Diptera) dominated samples from the East Fork of Crooked Creek. Stoneflies comprised a relatively small proportion of all samples, but were generally more abundant in Big Creek streams than South Fork Salmon streams.

Comparisons of macroinvertebrate densities between 2002 samples and samples collected before the 2000 Big Creek fires are not available because some of the 1998 samples were collected with a kick net and therefore do not provide reliable density estimates. However, comparisons of relative abundance of insect taxa show a general decrease in relative abundance of mayflies in most streams and an increase in relative abundance of true flies following the 2000 wildfires (Figure 2). Densities of Oligochaete worms increased sharply from 2003 to 2004 in Beaver Creek and both forks of Crooked Creek, and to a lesser extent in Big Ramey Creek. Responses of caddisflies and stoneflies varied from stream to stream within the subbasin. Many Diptera species are opportunistic or have high tolerance for a wide range of habitat conditions (Merritt and Cummins 1996) and may be well-suited for persisting in or re-colonizing streams that have been affected by fires (Mihuc and Minshall 1995, Minshall 2003). In contrast, Ephemeroptera species tend to be sensitive to impaired stream conditions and tend to decline in abundance following fires (Minshall 2003).

At our sampling sites, Crooked Creek is a relatively low-gradient drainage that was intensely burned in the 2000 wildfires, and embeddedness (or degree of fine sediments present in the substrate) continued to increase during our 2004 sampling efforts. The amount of sediment present may contribute to lower macroinvertebrate densities in these streams, and explains the high proportion of Diptera in East Fork Crooked Creek samples. Macrophytic vegetation has increased in the Crooked Creek forks each year following the 2000 fires.

Future Work

Macroinvertebrate and stream sampling for this study were completed in 2004. Further analyses will include examination of stream habitat changes following fire in relation to macroinvertebrate communities; comparisons of pre- and post-fire macroinvertebrate community composition in the Big Creek subbasin; and comparisons of macroinvertebrate communities in burned and reference streams in the South Fork Salmon subbasin.

Work Summary

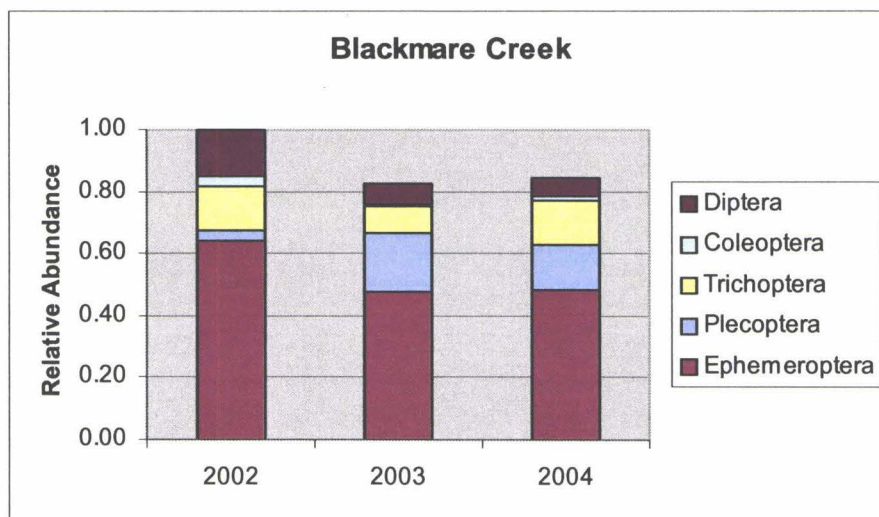
We collected 5 macroinvertebrate samples from 14 streams for a total of 68 samples. We sorted each sample in the laboratory, identified macroinvertebrates to genus where possible, and counted the number of each macroinvertebrate taxon in each sample. We calculated density, taxa richness, relative abundance, Shannon diversity, and evenness estimates for each sample. In this progress report, we describe these preliminary results from 2004, the third year of a three-year study.

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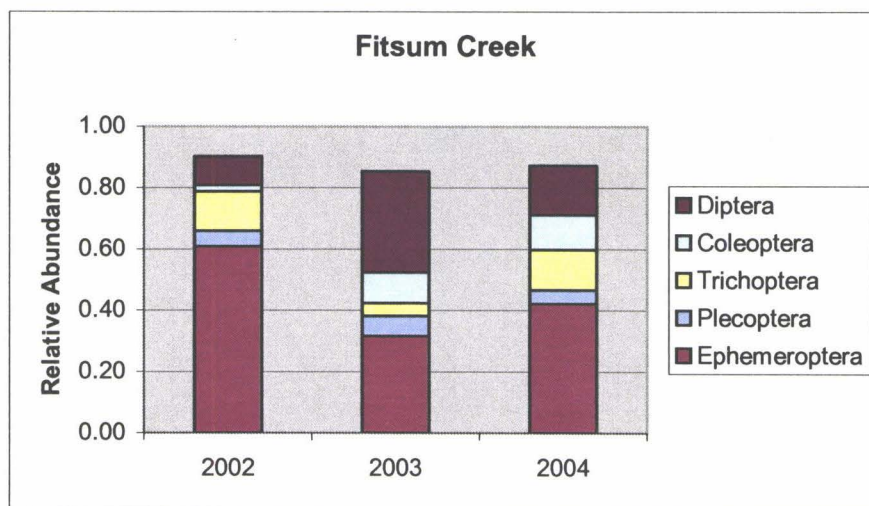
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Figure 1. Relative abundance of benthic invertebrate orders in South Fork Salmon (SFS) tributaries: (a) Blackmare Creek, (b) Fitsum Creek, (c) Fourmile Creek, (d) Parks Creek, (e) Reegan Creek, and (f) West Fork Buckhorn Creek, 2002-2004; and (g) Deadman Creek, 2003-2004.

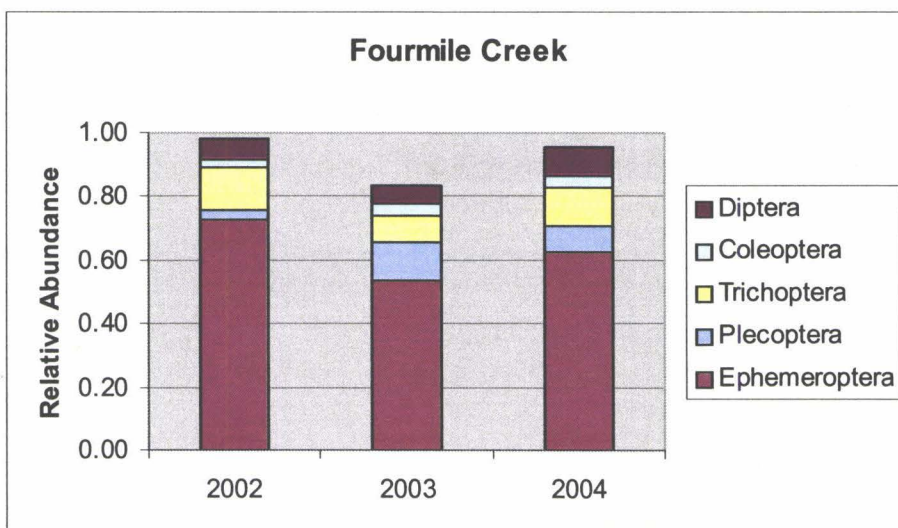
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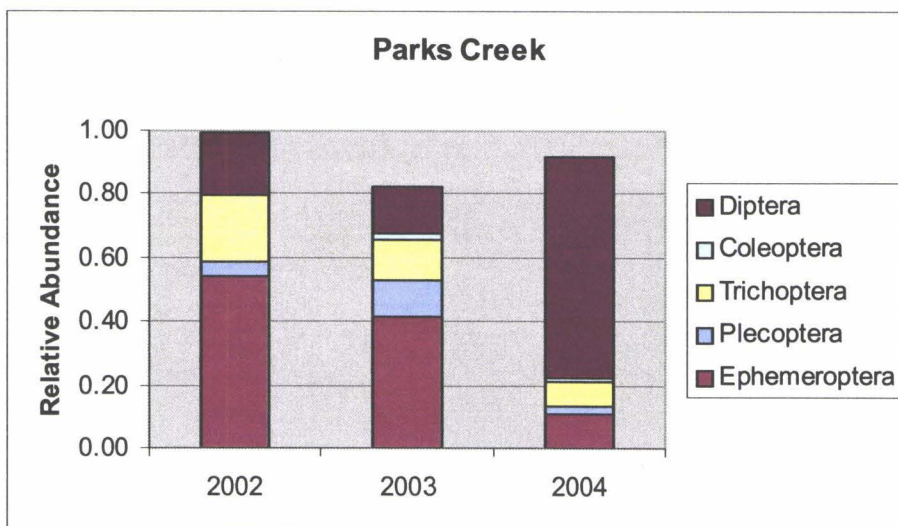
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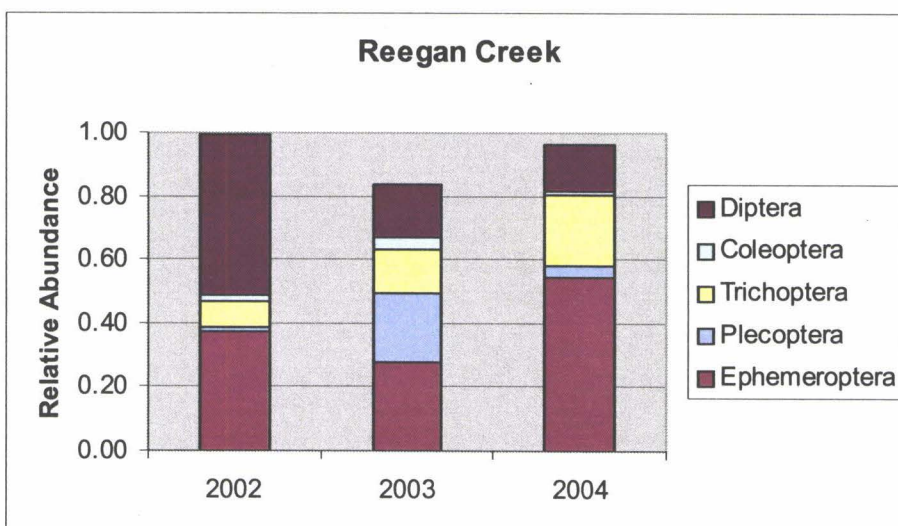
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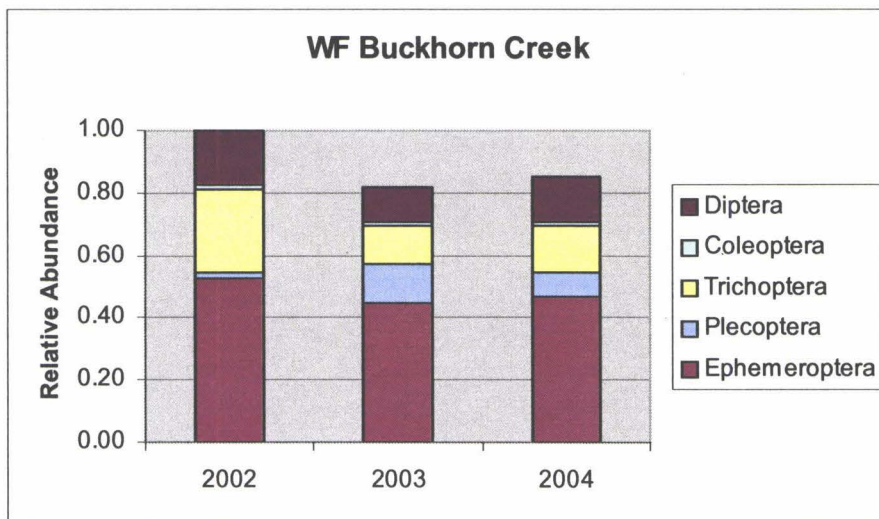
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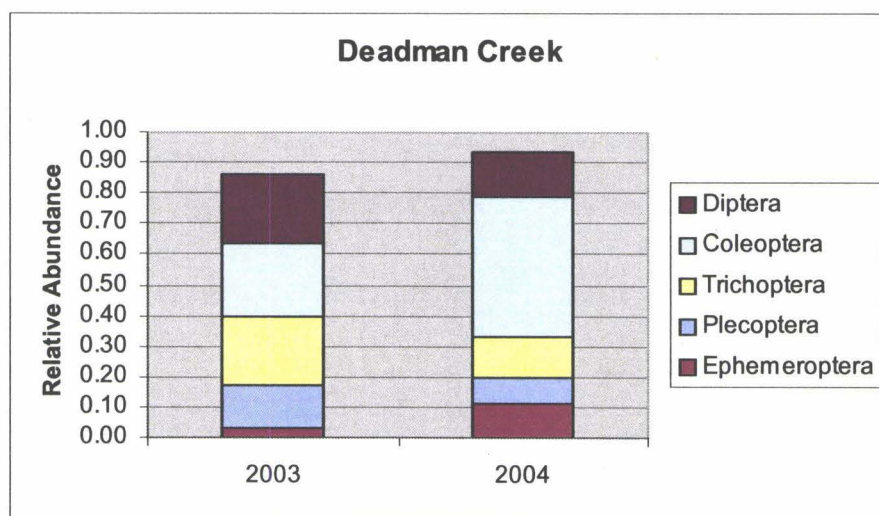
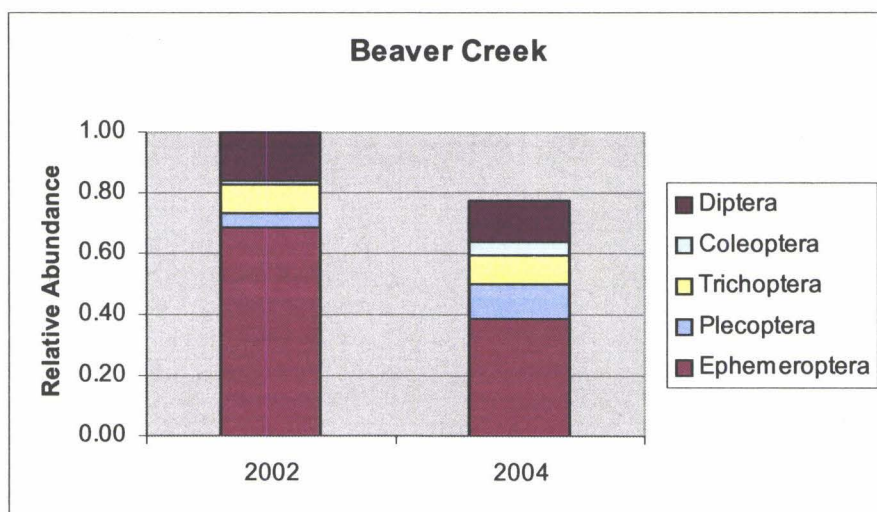
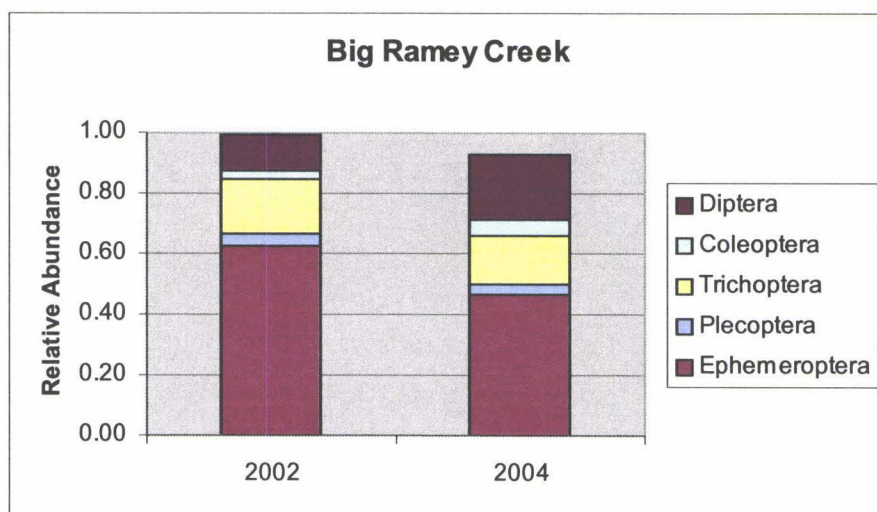


Figure 2. Relative abundance of benthic invertebrate orders in Big Creek (BC) tributaries: (a) Beaver Creek and (b) Big Ramey Creek, 2002 and 2004; and (c) Cabin Creek, (d) East Fork Crooked Creek, and (e) West Fork Crooked Creek, 2002-2004.

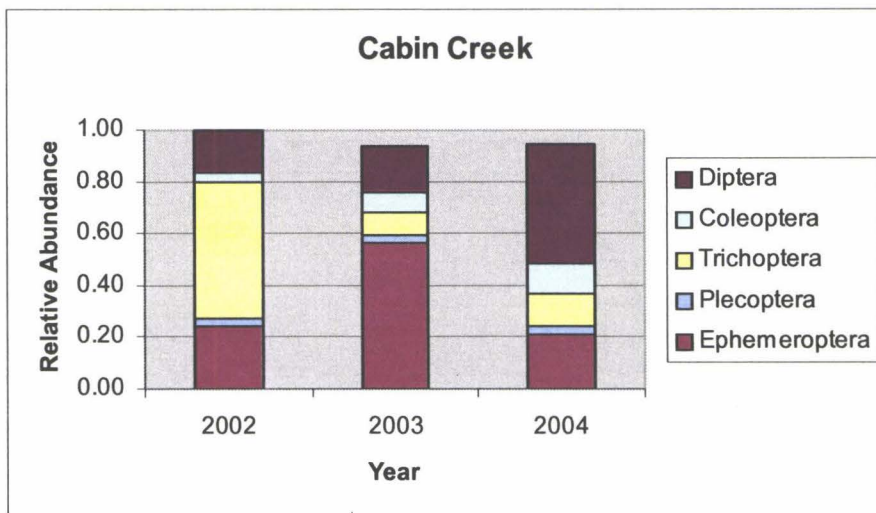
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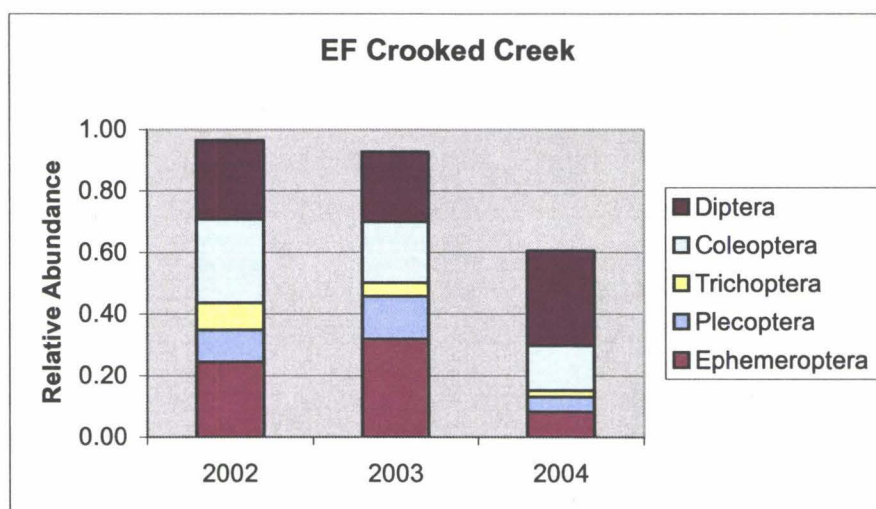
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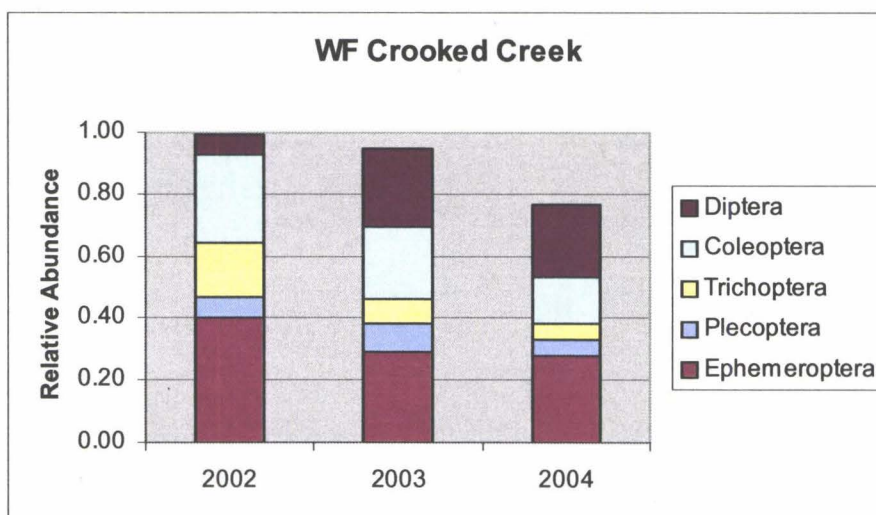


Table 1. Benthic invertebrate sampling locations and dates.

Study Area	Stream Name	Pre-burn Sampling ¹	Post-burn Sampling
South Fork Salmon River	Reegan Creek	1999, 2000	2002-2004
	Parks Creek	1999, 2000	2002-2004
	Deadman Creek	1999	2003-2004
	Fitsum Creek	2000	2002-2004
	WF Buckhorn Creek	2000	2002-2004
	Fourmile Creek	2000	2002-2004
	SF Blackmare Creek	2000	2002-2004
Big Creek	Beaver Creek	1999	2002, 2004
	Big Ramey Creek	1999	2002, 2004
	EF Crooked Creek	1999	2002-2004
	WF Crooked Creek	1998	2002-2004
	Snowslide Creek	1999	2002
	Cabin Creek	1999	2002-2004
	Canyon Creek	Not sampled	2002-2003

¹ During pre-burn sampling conducted in 1998-2000, three benthic invertebrate samples were collected along a 30-m stream transect; all other sampling methods were the same as those used for this study

Table 2. Stream characteristics measured at sampling points.

Stream Attribute	Measurement units	Method/Equipment
Elevation	m	USGS 1:24,000 maps; GPS
Order	--	USGS 1:24,000 maps
Gradient	%	Clinometer
Bank vegetation	Descriptive class	Dominant species
Large organic debris	Number per 10-m interval	Ocular estimate
Water temperature	°C	Field thermometer
Air temperature	°C	Field thermometer
Conductivity	µS	Conductivity meter
pH		pH meter
Current velocity	m/sec	Velocity meter
Canopy closure	% closure	Densiometer
Bankfull width	m	30-m measuring tape
Wetted width	m	30-m measuring tape
Depth	cm	meter stick
Pocket pools	Number per 10-m interval	Ocular estimate
Step pools	Number per 10-m interval	Ocular estimate
Substrate composition	% of 8 substrate classes	Ocular estimate
Embeddedness	% surface fine sediment	Ocular estimate
Stream habitat	Descriptive class	Ocular estimate

Table 3. Indices of benthic invertebrate samples in South Fork Salmon River and Big Creek tributaries, 2004.

Study area	Stream name	Mean density (N/0.1 m ²)	Mean taxa richness (N/0.1 m ²)	Dominant taxon (% of sample)	Number of unique taxa	Shannon diversity	Evenness
SF Salmon	Reegan	168	13	<i>Caudatella</i> (29)	1	2.21	0.62
	Parks	145	9	<i>Epeorus</i> (24)	0	2.08	0.79
	Deadman	243	14	Chironomidae (18)	3	2.22	0.70
	Fitsum	191	15	<i>Baetis</i> (50)	4	2.07	0.71
	WF Buckhorn	100	8	<i>Baetis</i> (39)	0	2.54	0.73
	Fourmile	231	10	<i>Baetis</i> (28)	0	2.12	0.65
	Blackmare	114	11	<i>Baetis</i> (47)	0	2.29	0.68
SF Salmon Mean		170	11		12 ^a	2.22	0.56
Big Creek	Beaver	290	14	<i>Epeorus</i> (25)	1	2.16	0.70
	Big Ramey	173	14	<i>Baetis</i> (23)		2.40	0.78
	EF Crooked	307	7	Chironomidae (35)	1	2.65	0.74
	WF Crooked	433	13	<i>Heterlimnius</i> (26)	0	2.36	0.73
	Cabin	341	18	<i>Baetis</i> (39)	1	2.11	0.64
Big Creek Mean		309	14		9 ^b	2.38	0.60

^aNumber of taxa found in at least one stream in the SFS study area but not found in any Big Creek study area streams.

^bNumber of taxa found in at least one stream in the Big Creek study area but not found in any SFS study area streams.

^cSnowslide and Canyon Creeks not sampled in 2004